AGRICULTURAL NOTES.

PUBLISHED BY

PORTO RICO AGRICULTURAL EXPERIMENT STATION, MAYAGUEZ
OFFICE OF FARM MANAGEMENT, FEDERAL BUILDING, SAN JUAN

No.31 Page 1. San Juan, Porto-Rico, September, 1926.

SOME PINEAPPLE PROBLEMS.

15th ARTICLE. - THE NITROGENOUS PRODUCTS.

By Henry C. Henricksen.

NITROGEN. - While the plant obtains carbon from the carbon dioxid of the air and by the process of photosynthesis changes it into carbohydrates, it cannot utilize the nitrogen of the air in the same manner. Nitrogen, like potash and all other inorganic elements, enters the plant through its roots. But no element enters the plant as such. All are present, in the soil, in combination with one or more other elements and the plant utilizes them in whichever form they are present, provided it is capable of doing so. Nitrogen is present, in combination with oxygen, in the form of nitric acid. That, however, combines with any base present such as potassium sodium, lime, etc. and these are some of the salts from which the plant usually obtains its nitrogen. It also combines with hydrogen, forming ammonia. That, being a base, combines with any acid that may be present and from such salts some plants derive their nitrogen supply. Not all plants can utilize ammonia to good advantage and the pineapple plant is one of these. That is, the plant can actually keep alive with ammonia as the source of nitrogen but the growth is far too slow to be of commercial importance. The question is of minor importance to the pineapple grower, for whenever he applies fertilizer in the form of ammonia it quickly changes, in the soil, into the nitrate form, which is the one preferred by the plant. This will be discussed further in another article.

In the plant the first appearance of nitrogen is in the form of nitrates. It is found, as such, in the stalk, in the white leaf bases and also in the green leaf according to age, vigour of growth and amount present in the soil. Therefore, a test for nitrates may furnish much useful information. The test is so simple that any planter may perform it without difficulty.

DIRECTIONS FOR NITRATE DETERMINATION. - Take as much diphenylamine as will lay on a ten cent piece. Heap that up on a sheet of paper and cut the heap in four parts. Take one part and dissolve in about twenty drops sulfuric acid. After it is dissolved add about 30 cc. or 1 oz. sulfuric acid. Keep the solution in a bottle for use when needed. For making the test cut a plug from the leaf with a small punch, split the plug so as to expose the tissue and lay the two halves, tissue up, on a white plate, drop a few drops of the acid on each half and note the blue color that develops. This is proportionate to the amount of nitrate nitrogen present.

The following has been observed in this investigation: When an abundance of nitrate nitrogen is present in the soil an abundance is present in the white leaf bases. If that is not the case it is because the leaf is old and has ceased to function. In the green part of the normal leaf nitrogen is present a longer or

shorter distance from the base according to the vigour of growth. In a very vigorous leaf a deep blue color may develop with a plug close to the tip, whereas in one, of which the tissue is mature, no color may develop with a plug six inches from the base. The test has been found exceedingly useful in determining the kind of growth produced by different fertilizers which will be referred to in another article. - Also the test will show whether or not the soil is supplied with nitrogen, but when used for that purpose certain precautions must be taken. The plants must be normal and not too old. The test should not be made within two weeks after fertilizing and three weeks or more is safer for the pineapple plant is sluggish in responding. It all depends upon the state of growth. A vigorously growing plant that has gradually become nitrogen hungry may respond quickly to nitrogen fertilizer, if the hunger period has not been too long. On the other hand a plant that has suffered from a lack of nitrogen for a long time may not respond at all. That is, the tissue may have become so congested that the leaves are incapable of rejuvenating, which will be discussed in another article.

THE CHANGE OF NITROGEN IN THE LEAF. - The knowledge of nitrogen metabolism in plants is not very complete. The first product formed is supposed to be, usually, amino acids. That transitional stage is present in the pineapple leaf, in such small quantity that it was deemed unprofitable to determine it quantitatively.

As an abundance of nitrate nitrogen is found in the white leaf-base and as the content diminishes, inch by inch, in the green part it is apparent that something is present in the green leaf, which is absent from the white leaf-base and which is the cause of transformation from nitric acid to the more complex nitrogen combinations. The chlorotic leaf, which is always more or less feeble in growth, contains an abundance of nitrates almost to the tip. This does not, necessarily, indicate that the leaf takes it up rapidly, as in the case of one in a state of vigorous growth. It rather points towards a condition which does not allow it to change into amino acids and the more complicated proteins. In other words the chlorotic leaf, containing but little chlorophyll, seems to act similar to the white leaf bases in respect to the nitrogen metabolism.

P R O T E I N. - In this discussion no attempt will be made to segregate the various proteins. The total protein was determined by the usual Kjeldahl method in the leaves of a large number of plants that were different one from another. The amount of nitrogen obtained by this method was multiplied by 6.25 and the resultant figure used to denote the total protein, in per cent of dry matter, present in the leaf.

All samples in which the protein was determined were also analysed for carbohydrates. That is, the sample was heated to about 95°C for three hours with a 1% hydrochloric acid, as explained in a former article and the hydrolysed sugar determined. The results from the two determinations, of representative samples, are tabulated in the following table to show the ratio in which they are present in plants that differ from one another in appearance and otherwise.

PROTEIN CARBOHYDRATE RATIO.

No.		Protein.	Carbo-hydrates.	Protein Carbohydrate Ratio.
42A	Young leaves, extra vigorous growth	12.59	13.	1.03
45	Old leaves, extra vigorous growth	12.69	14.75	1.16
31A	Mature leaves, representative one year old plant	6.12	22.4	3.66
31B	Young leaves, same plant	7.87	19.56	2.48
31C	White leaf bases, same plant	7.97	28.4	3.56
59	Poor plant two years old	3.93	30.4	7.74
60	Normal plant, plat adjoining former	5.68	31.35	5.52
74A	Red leathery leaves, abnormal plant	4.07	33.7	8.28
81	Poor chlorotic plant	3.97	40.1	10.1

No.42A in the table are leaves from a plant of which the heart had been burned out with fertilizers, as mentioned under carbohydrates. Such growth is abnormal but it can be made to serve a useful purpose as will be pointed out in another article. In such leaves the protein content practically equals the carbohydrate content.

No.45 are also abnormal leaves because of the fertilizers applied. In article No.8 some doubt was expressed as to the necessity of phosphate fertilizers. Since that was published pot and field experiments have been conducted for the purpose of gaining more light on that question. The results show, among other things, that phosphate induces senescence in the plant. A plant fertilized with ammonium sulphate and potassium sulphate retains its vigour much longer than one receiving the same salts plus phosphate. This plant, No.45, is from a no-phosphate plat. The protein carbohydrate ratio is very low as shown by the figures, that is, the leaf is a protein leaf almost as much as it is a carbohydrate leaf. The growth is vigorous and the tissue is not clogged up as shown by the nitrate test. Nitrates were found in these leaves 20 to 30 inches from the bases, when the plant was 16 months old, which is unusual.

No.31A are mature leaves from plants fertilized with a mixture containing phosphate. The sample is, more or less, representative of well grown field plants in Porto Rico. It is noticeable that the protein content is but half of that of the no-phosphate plant, while the carbohydrate content is about one-third greater.

No.31B are young leaves from the same plant, showing how the content changes with age. In the young leaves the protein-carbohydrate ratio is much lower than in the mature leaf.

No.31C shows the characteristic composition of the white leaf base. The protein content is about like that of the green part of the young leaf but the carbohydrate content is much greater. It is natural, of course, that it should be so

for the carbohydrates elaborated by the leaf must pass through the base on its way to the stalk where it is deposited as reserve material.

No.59 are leaves from an old plant growing in a typically poor spot. The plant is stunted, the leaves are small and more or less chlorotic. It is a typical carbohydrate leaf although not extremely so.

No.60 are leaves from a normal green plant from normal soil adjacent to No.59. It is included in the table for comparison. The plant is small for the soil is not of the best but it is apparently normal as shown by the size and color of the leaves. The carbohydrate content is high, which is reasonable, as the plant is two years old, but the protein content is almost that of an average one year old leaf, which brings the ratio down considerably below than in the former plant. This serves to emphasize that a plant may be stunted in growth and not commercially profitable, but if the chlorophyll content is not impaired the growth is not lieable to be abnormal.

No.74A are leathery leaves of a 15 months old plant. It is included in the table to show the extreme high protein carbohydrate ratio that may develop under unfavorable conditions.

No.81 are leaves from representative plants of a field in which about 90% of all the plants were chlorotic at six months old. The chlorosis was caused by soil conditions that were curable by an application of sulfur. Referring to the table it is readily apparent that these plants are almost identical with Nos. 59 and 74A in regard to the protein content. The main difference is in the carbohydrate content, that being so much greater than in any of the former the carbohydrate-protein ratio is naturally greater.

From the above data the following conclusions may be drawn (1) As long as the growth remains very vigorous the protein content of the leaves is almost equal to that of the carbohydrates. (2) When the growth is less vigorous, either due to abnormality in young plants or to maturity in older plants the content of the carbohydrates is three to six times higher than that of proteins. The variation is, practically in all cases, correlated with the suitability of the soil and the fertilizers applied. (3) In the abnormal plants, which are conspicuously off-color, the variation in the carbohydrate-protein ratio is always correlated with the chlorophyll content. That is the ratio is lowest in those with the greenest leaves and highest in those with the palest leaves.